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Revisiting historical climatic signals to better explore the future: prospects of water cycle changes in Central Sahel

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Abstract. Rainfall and climatic conditions are the main drivers of natural and cultivated vegetation productivity in the semiarid region of Central Sahel. In a context of decreasing cultivable area per capita, understanding and predicting changes in the water cycle are crucial. Yet, it remains challenging to project future climatic conditions in West Africa since there is no consensus on the sign of future precipitation changes in simulations coming from climate models.

The Sahel region has experienced severe climatic changes in the past 60 years that can provide a first basis to understand the response of the water cycle to non-stationary conditions in this part of the world. The objective of this study was to better understand the response of the water cycle to highly variable climatic regimes in Central Sahel using historical climate records and the coupling of a land surface energy and water model with a vegetation model that, when combined, simulated the Sahelian water, energy and vegetation cycles. To do so, we relied on a reconstructed long-term climate series in Niamey, Republic of Niger, in which three precipitation regimes can be distinguished with a relative deficit exceeding 25 % for the driest period compared to the wettest period. Two temperature scenarios (+2 and +4 °C) consistent with future warming scenarios were superimposed to this climatic signal to generate six virtual future 20-year climate time series. Simulations by the two coupled models forced by these virtual scenarios showed a strong response of the water budget and its components to temperature and precipitation changes, including decreases in transpiration, runoff and drainage for all scenarios but those with highest precipitation. Such climatic changes also strongly impacted soil temperature and moisture. This study illustrates the potential of using the strong climatic variations recorded in the past decades to better understand potential future climate variations.

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